United States Patent [19]

Cousins

[11] **4,368,786**

[45] **Jan. 18, 1983**

[54] **DOWNHOLE DRILLING APPARATUS**

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[52] **U.S. Cl.** **175/78;** 175/61; 175/320; 464/19

[58] **Field of Search** ..... 175/52, 61, 78, 79; 166/55.2, 55.3; 64/2 R

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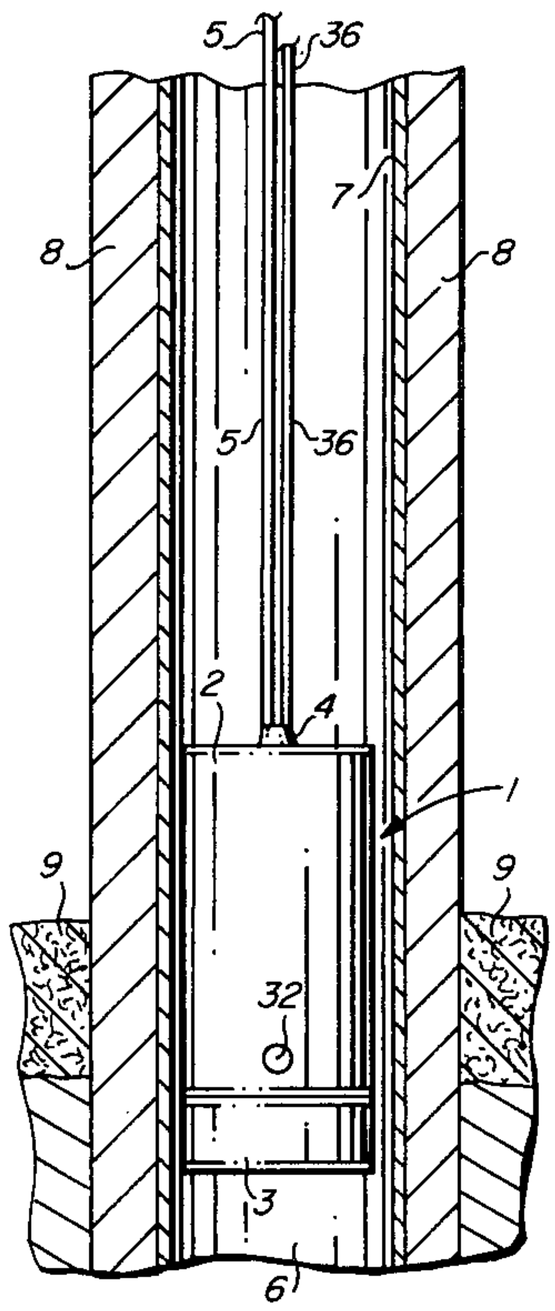
Attorney, Agent, or Firm—John M. Harrison

[57] **ABSTRACT**

A downhole drilling apparatus for drilling holes at right angles to a vertical well hole which includes a tubular housing capable of being inserted in the well hole and containing at least one elbow tube or guide, and multiple tapered and splined, interlocking drilling segments which are rotatably stacked and nested as a segment string in the guide tube with the bottom one of the drilling segments designed for drilling through the well casing, the concrete sheathing and into the production interval, and the top one of the segments cooperating with a drive means to effect rotation of the nested segments inside the guide. The guide tube extends from the tubular housing wall upwardly and telescopes at the top of the segment string to permit slidable movement of the drive means inside the tubular housing and slidable and rotatable movement of the nested segments inside the guide tube and into the production interval. In a preferred embodiment of the invention a pair of guide tubes and cooperating segment strings are provided in the tubular housing for drilling two transverse drain holes simultaneously.

19 Claims, 10 Drawing Figures



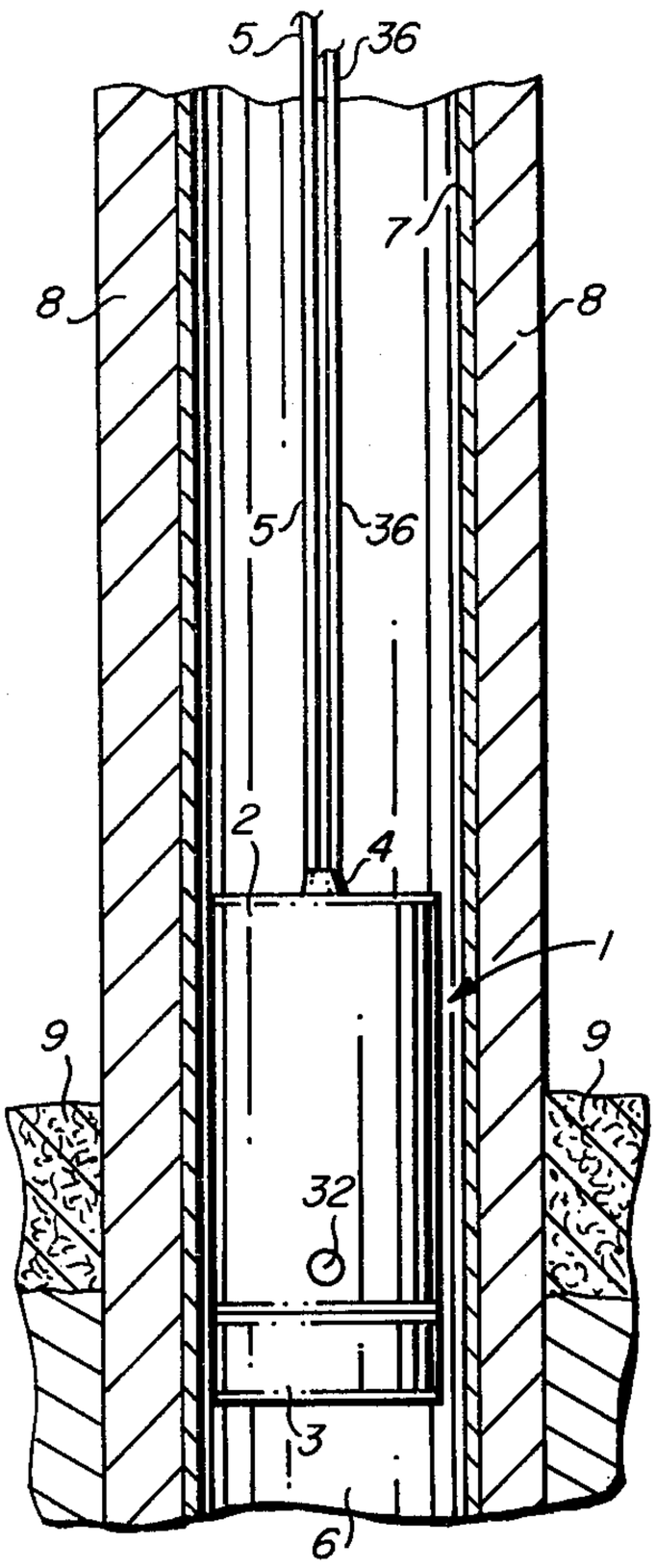


FIG-1

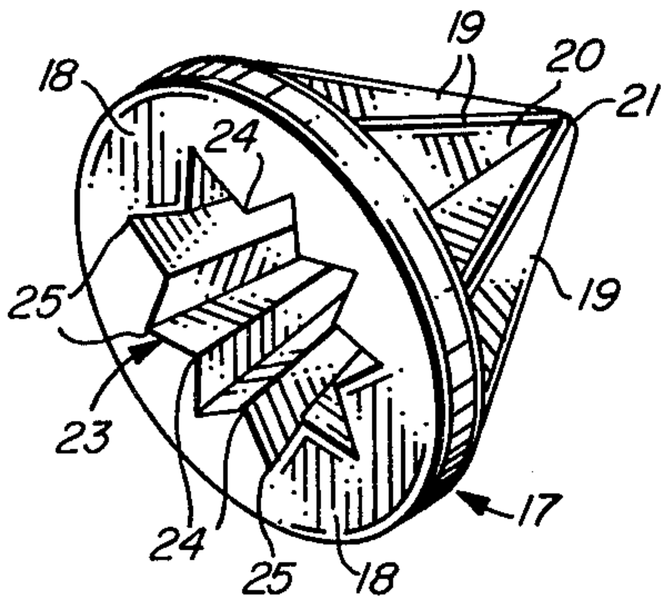


FIG-3

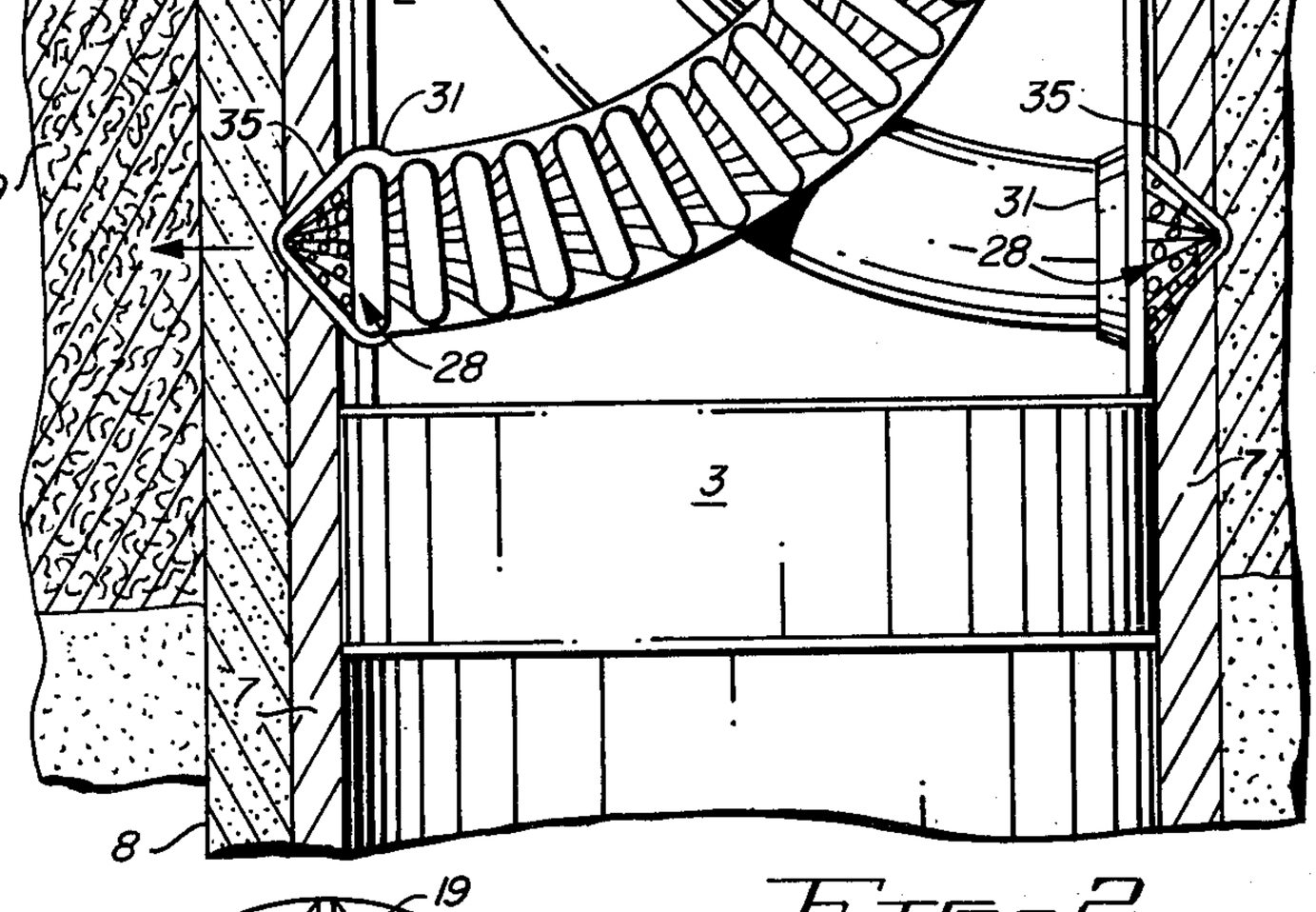


FIG-2

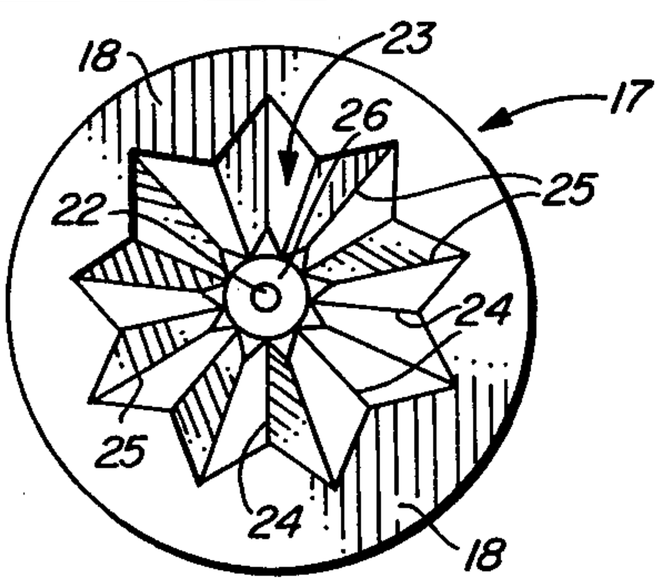


FIG-4

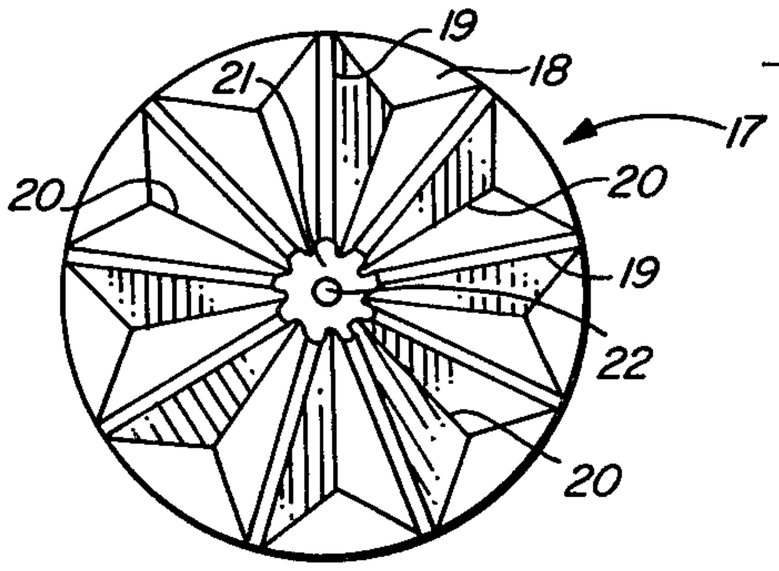


FIG-5

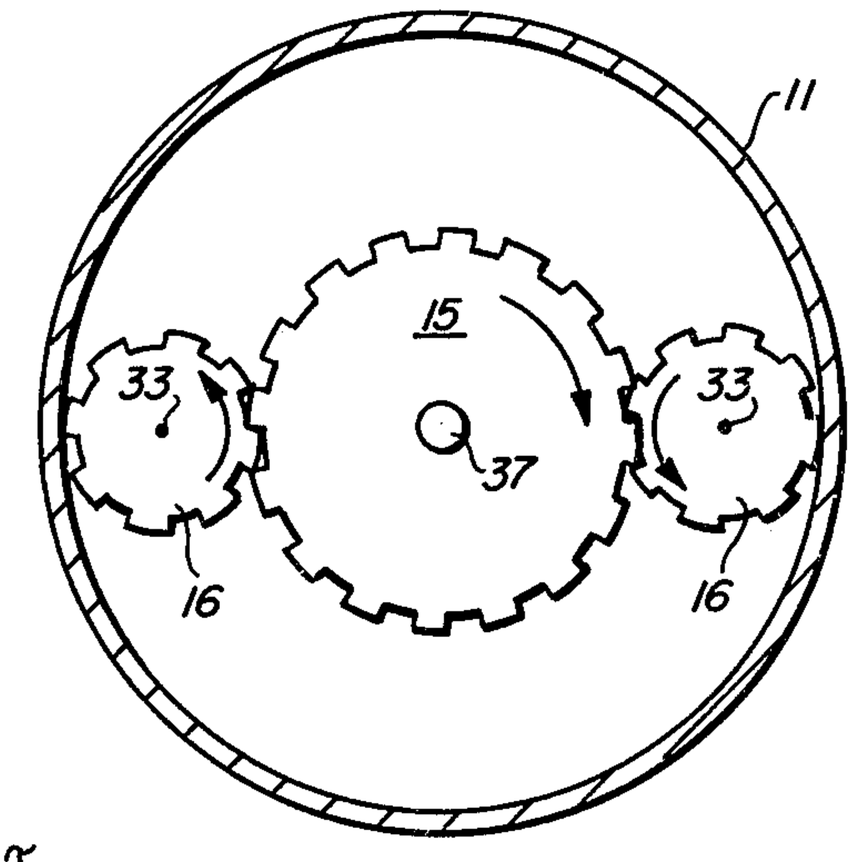


FIG-6

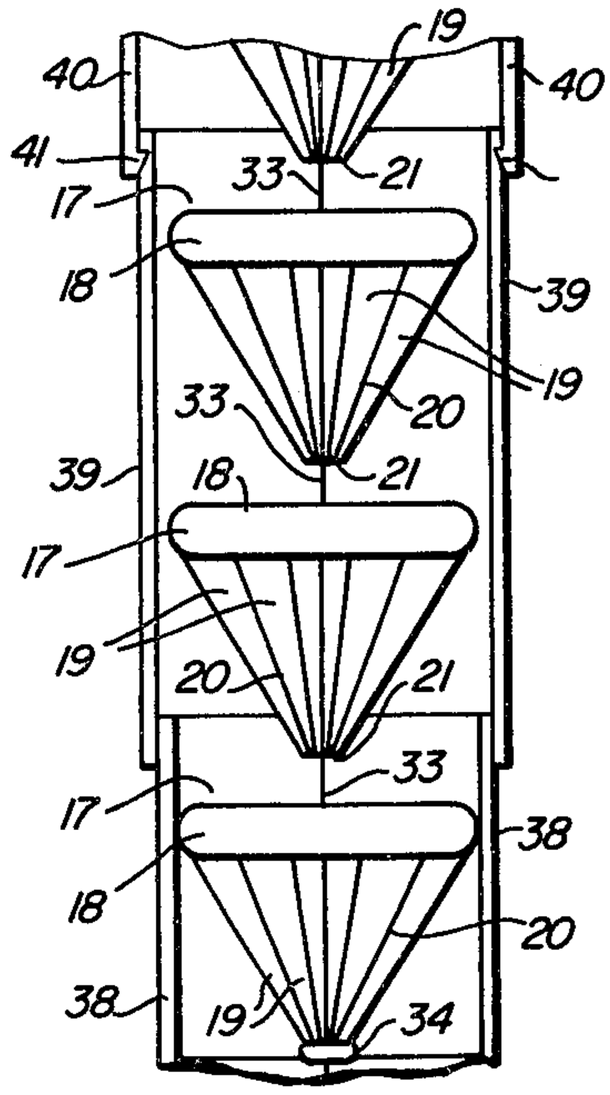


FIG-7

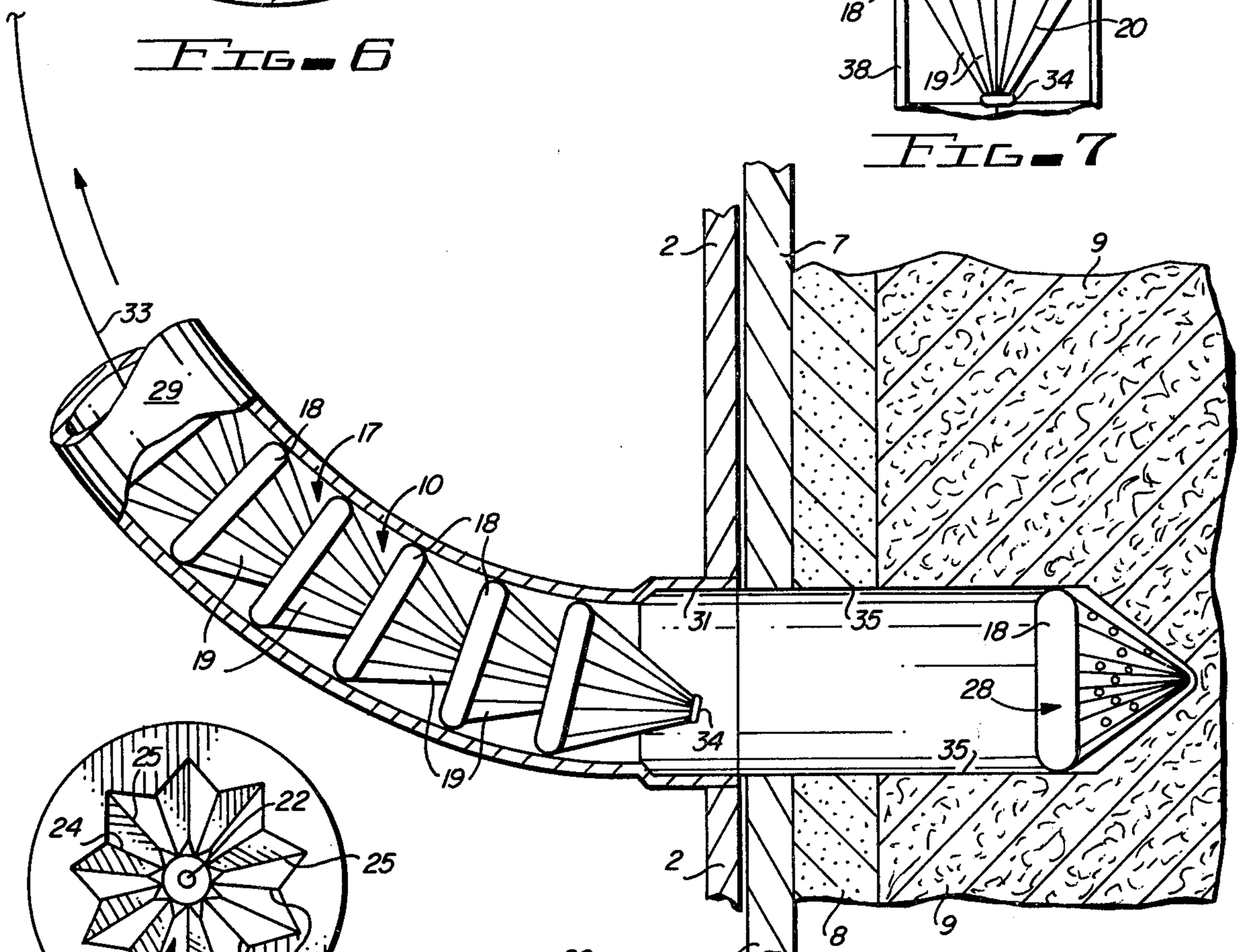


FIG-8

FIG-9

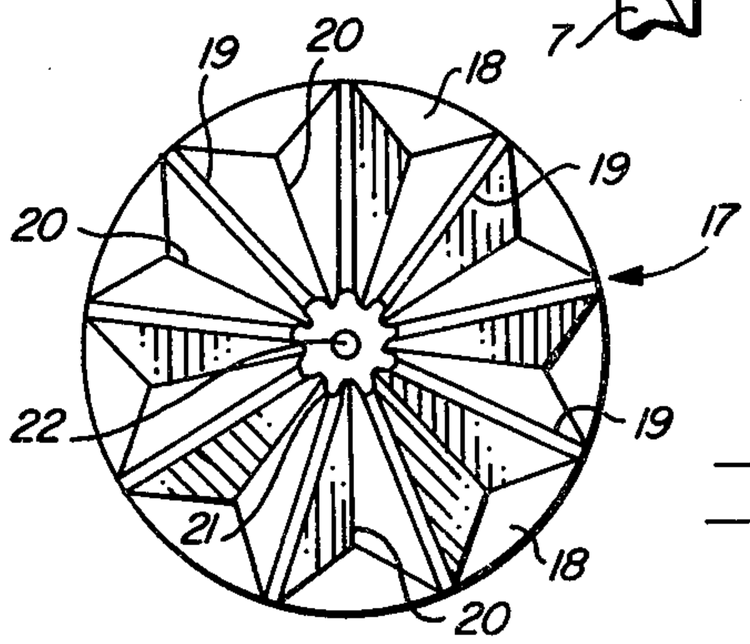


FIG-10

DOWNHOLE DRILLING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the perforation of oil and gas wells to achieve maximum production of oil and gas, and more particularly, to a self-contained, downhole drilling apparatus for drilling production drain holes at right angles to a central well bore.

Production of hydrocarbons from oil and gas wells involves drilling a well bore to the producing interval and sealing a casing in the bore by pumping cement into the annular space between the bore and casing. Because of the varying porosity of the production intervals and other factors, it is necessary to provide lateral perforations or drain holes in the production interval for collection of the hydrocarbon fluid in the well bore. Conventional techniques for achieving this objective are frequently difficult to implement and the results sometimes defy accurate prediction.

The most basic and general benefit of a drain hole or drain holes in the production interval or zone of an oil or gas well is that of increasing the amount of formation surface exposed to the well bore. In addition to this desirable formation exposure, it has been found that there is a significant relationship between horizontal drain hole depth and an increase in bottom hole pressure. Productivity of a completed and perforated well depends upon the number of drain hole perforations in the production interval, the diameter and depth of penetration of the perforations, and the distribution of the drain hole perforations. Production in many wells has decreased over the years to the point of marginal profitability due to collapse of the drain hole walls, which reduces the flow of hydrocarbon fluid from the producing interval or "pay", into the well.

2. Description of the Prior Art

Conventional techniques for achieving production of hydrocarbons from the producing intervals of oil and gas wells include "perforating" the zone of production surrounding the well bore by means of perforating guns which are lowered into the well bore and fire projectiles through the well casing and concrete sheath, and into the production zone to create drain holes which allow hydrocarbons to flow from the production strata into the well bore. Other methods include the use of explosive, shaped charges which "jet" an aperture into the formation to create the desired hydrocarbon drainage. However, most of these devices do not have sufficient force to penetrate deep into the formation, and many times, the projectiles or explosive charges must penetrate two strings of casing, two cement sheaths and a wall of hard rock. Improved techniques which use equipment capable of achieving deeper projectile penetration and maximum backsurging to clean the drain holes are still capable of effecting only limited penetration into the production strata, even under ideal conditions. Other techniques include using chemical charges such as thermite which are ignited and create an extremely hot charge which burns through the casing, concrete and hydrocarbon-bearing zone. However, these devices are sometimes unreliable and are often not able to penetrate far enough into the "pay" zone to achieve a significant increase in hydrocarbon flow.

Other devices designed for lowering in the well for the purpose of boring and drilling holes at right angles to the well bore at the production interval, have been

proposed, but many problems have been encountered in these systems. For example, the relatively low bit rotation speed generally necessitated by using a curved shaft sometimes requires too much time to achieve significant penetration, and increasing the bit rotational speed and shaft load frequently causes failure of the shaft. Generally, conventional drilling devices have not proved capable of sustaining the high compressive loads necessary to penetrate the well casing, concrete sheath, rock and producing interval within an economical time frame without failure. Other problems have been encountered with bit retrieval and freedom of rotation of the drilling string.

An early device for drilling drain holes transverse to the well bore is disclosed in U.S. Pat. No. 1,367,042 to B. Granville. This apparatus includes a rigid pipe fitted with an elbow; a flexible tube positioned inside the pipe and extending through the elbow; a drill bit rotatably mounted at the outer end of the flexible tube; and a flexible shaft attached to the drill bit and lying within the flexible tube. A drive mechanism is attached to the flexible shaft for driving the shaft and rotating the bit.

Other methods and mechanisms for achieving transverse drilling in a well bore are taught in U.S. Pat. No. 3,958,649 to George H. Bull, et al, which mechanisms include a flexible, spring biased, telescopic fluid conduit fitted with a turbodrill on the lower end designed to extend from an opening in the side of an elongated, cylindrical housing. The conduit further includes multiple, axially aligned spools with interconnecting cylinders and compression rings in the cylinders to create the desired flexibility and telescopic action.

Another downhole drilling system is disclosed in U.S. Pat. No. 4,051,908, to W. B. Driver, which system includes a 90 degree elbow attached to the downhole end of a tube section having a small diameter. The top of the tube section is attached to a tubing string of relatively large diameter, which houses a downhole electric motor. A small drill bit and flexible drill pipe operate in the small tube section to effect drilling into the production formation.

Yet another perforating tool for drilling transverse holes in oil and gas wells as disclosed in U.S. Pat. No. 4,185,705 to Gerald Bullard. This tool includes a housing for insertion in the casing and provided with a detachable boot. A pair of motors are used to rotate a flexible drill and to advance and retract the flexible drill shaft in order to effect penetration of the production formation with the drill.

It is an object of this invention to provide a downhole, transverse drilling apparatus which is self-contained and can be lowered into a well bore to drill one or more drain holes of selected depth into a producing interval to increase the flow of hydrocarbons from the interval into the well bore.

Another object of the invention is to provide a downhole drilling apparatus for drilling drain holes at right angles to a vertical well hole or bore, which apparatus can be lowered into the well bore by wire-line, stabilized in the bore, and activated to drill holes of selected size and depth in the hydrocarbon-producing strata.

Yet another object of the invention is to provide a self-contained, downhole, transverse drilling apparatus for drilling drain holes in oil and gas wells by penetrating beyond the "well skin" into undamaged production formation and increasing the flow of hydrocarbons into the well bore.

A still further object of this invention is to provide a self-contained, downhole drilling device which can be lowered into a well bore adjacent to a producing strata or interval and activated to bore through the well casing, concrete sheath and production interval to create one or more drain holes for enhancing the flow of hydrocarbons into the well bore, and particularly, for enhancing hydrocarbon production from characteristically slow-flowing formations such as chalk, clay and tight sands and aiding in artifically induced secondary and tertiary hydrocarbon recovery systems such as water and fire floods.

Yet another object of the invention is to provide a transverse, downhole drilling system which is self-contained in a tubular housing and includes a drilling string or strings characterized by multiple tapered, splined segments which nest and interlock inside one or more telescoping guide tubes in such a manner as to permit sufficient lateral movement to traverse the 90 degree bend in the guide tubes, with a drill bit on the lower end of the string and a gear-engaging means on the top end for engagement with a drive system and effecting rotation of the string and drill bit.

SUMMARY OF THE INVENTION

These and other objects of the invention are provided in a downhole, transverse drilling apparatus which is characterized by a tubular housing containing at least one telescoping guide tube having a relatively large radius, 90 degree elbow and at least one drill string in the guide tube and formed by multiple tapered, splined drill string segments which interlock and nest and are driven by a self-contained drive mechanism to force a drill bit attached to the lowest of the segments and the accompanying drill string through the well casing, concrete sheath and into the production formation. According to a preferred embodiment of the invention the string of segments is removed from the drilled drain hole or holes by means of a cable running through the center of the segments, and the bit may be left in the drain hole.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention will be better understood by reference to the accompanying drawings, wherein:

FIG. **1** is an elevation of the downhole drilling apparatus of this invention positioned in a well bore;

FIG. **2** is a front elevation, partially in section, of the downhole drilling apparatus illustrated in FIG. **1**, more particularly illustrating the drill strings and guide tubes;

FIG. **3** is a perspective view of a drill string segment;

FIG. **4** is a bottom elevation of the drill string segment illustrated in FIG. **3**;

FIG. **5** is a top elevation of the drill string segment illustrated in FIGS. **3** and **4**;

FIG. **6** is a sectional view, taken along lines **6—6** in FIG. **2**, more particularly illustrating a preferred gear drive for driving the drill string;

FIG. **7** is a sectional view of the telescoping segment of the guide tube, illustrating mounting of the drill string segments on a cable for retrieval;

FIG. **8** is a sectional view of the apparatus housing and the lower segment of a guide tube, more particularly showing one string of the drill string segments retrieved from a drain hole drilled in the production interval;

FIG. **9** is a top view of a most preferred drill string segment; and

FIG. **10** is a bottom view of the drill string segment illustrated in FIG. **9**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. **1** of the drawings the downhole drilling apparatus of this invention is generally illustrated by reference numeral **1**, and includes a generally cylindrically shaped housing **2**, having a stabilizer or packer **3**, mounted on the bottom thereof. A wire line mount **4** is provided on the top of housing **2**, and is attached to a wireline cable **5**, which includes a conventional wire line and suitable electric wiring for energizing a downhole motor located in housing **2**, as hereinafter described. A drive housing cable **36** extends through wireline mount **4** and housing **2**, and is attached to the drive housing of downhole drilling apparatus **1**, as hereinafter described. Downhole drilling apparatus **1** is suspended in the well bore **6** of an oil or gas well to a point adjacent a zone of hydrocarbon production or interval **9** by means of wire line cable **5**. Casing **7** is mounted in the well in conventional fashion by means of a cement sheath **8**, as illustrated, and the diameter of housing **2** is slightly smaller than the inside diameter of casing **7** to permit downhole drilling apparatus **1** to be raised and lowered inside casing **7** in order to position the apparatus in alignment with the hydrocarbon-producing interval **9**. The depth of the producing interval **9** is determined by conventional well logging techniques well known to those skilled in the art.

Referring now to FIGS. **1** and **2**, and specfically to FIG. **2**, the downhole drilling apparatus **1** is illustrated partially in section, and includes a pair of curved guide tubes **29**, each having a bottom end **31** secured to the lower end of housing **2**, and blocked by a thin plug **32**, in housing **2**, as shown in FIG. **1**. The guide tubes **29** curve upwardly from each plug **32** in opposite directions to define a 90 degree bend across the inside diameter of housing **2** and terminate in upward extending, opposed relationship at top end **38**. A lower guide sleeve **39** concentrically and slidably overlaps top end **38** and is slidably and concentrically attached to an upper guide sleeve **40**, which is in turn attached to the bottom of drive housing **11**. An upper guide sleeve lock **41**, illustrated in FIG. **7**, serves to stabilize lower guide sleeve **39** in upper guide sleeve **40**. This mechanical arrangement facilitates telescoping of upper guide sleeve **40** on lower guide sleeve **39**, and lower guide sleeve **39** on top end **38** of guide tube **29**, as drive housing **11** descends in housing **2**. Drive housing **11** is free to slide up and down inside housing **2**, and is maintained in the top of housing **2** prior to drilling, by a drill string **10**, positioned in each one of guide tubes **29**. Guide tubes **29** are stabilized inside housing **2** by means of guide braces **27**, as illustrated in FIG. **2**.

Referring now to FIGS. **2–5**, each drill string **10** is formed by stacking multiple drill string segments **17** in guide tubes **29**, each of which segments include a flat segment head **18** and longitudinally tapering, exterior splines **19**, as specifically illustrated in FIGS. **3–5**. In a preferred embodiment of the invention each one of drill string segments **17** is shaped to include nine exterior splines **19**, which in turn taper in a direction transverse to the longitudinal axis of the splines to define exterior spline slots **20**, in a repetitive, geometric pattern to resemble a nine-point star when viewed from the bottom, as illustrated in FIG. **4**. The longitudinal taper of exterior splines **19** extends from the bottom surface of seg-

ment head **18** to a flat tip **21**, having a tip aperture **22** in the center thereof and extending through tip **21** into the hollow segment interior **23** of drill string segments **17**, as illustrated in FIGS. **3** and **5**. Referring again to FIGS. **3** and **5**, the segment interior **23** of drill string segments **17** is designed to register with the exterior surfaces of the drill segments, and includes multiple, spaced interior splines **24**, which project into segment interior **23**, and correspond to exterior spline slots **20**. Interior splines **24** extend from the surface of segment head **18** to tip seat **26**, which corresponds to tip **21**. Interior splines **24** also taper transversely to the longitudinal axis of the splines to define interior spline slots **25**, the latter of which corresponds to exterior splines **19**. Accordingly, drill string segments **17** will nest, stack and interlock to shape each drill string **10**, as illustrated in FIG. **2**, with the exterior splines **19** of one segment registering with the interior spline slots **25** of an adjacent segment, and corresponding registration of interior splines **24** of the first segment with exterior spline slots **20** of the second segment. This interlocking registration is not rigid, but permits lateral movement of the drill string segments **17** in the interlocking and nested configuration, such that the segments can easily bend to conform to the elbow bend in guide tubes **29**, and yet maintain an interlocking relationship. This lateral movement of drill string segments **17** in the registered and stacked configuration allows torque to be applied to the top of each drill string **10** to rotate the drill strings inside guide tubes **29** and drive a pair of segment drill bits **28**, for boring through casing **7**, cement **8**, and into producing interval **9**, as illustrated in FIG. **2**. In a most preferred embodiment of the invention the angle of taper of exterior splines **19** from segment head **18** to tip **21** is about 30 degrees with respect to the vertical when one of drill string segments **17** is viewed with the segment head **18** upwardly. Furthermore, when the drill segment **17** is viewed in this spatial orientation the angle of taper of exterior spline slots **20** and corresponding interior splines **24** from segment head **18** to tip **21** is about 10 degrees. The structuring of drill segments **17** facilitates a drill string **10** which is capable of bending about $\frac{1}{4}$ of an inch for each one of drill segments **17** used, in order to facilitate traversal of the bend in guide tubes **29** and yet maintain sufficient interlocking contact to effect rotation of segment bits **28**.

Referring now to FIGS. **2** and **6**, in a preferred embodiment of the invention drive housing **11** contains a drive motor **12**, having motor windings **13** and appropriate wiring **14** in electrical cooperation with the wiring in wire line cable **5** to energize drive motor **12**. Drive motor **12** carries a drive shaft **37** and a drive gear **15**, which rotatably cooperates with drill string gears **16**, as is more particularly illustrated in FIG. **6**. The bottom sections of drill string gears **16** are tapered and shaped to define exterior splines **19**, exterior spline slots **20**, and tips **21** to register with the interior spline slots **25** and interior splines **24**, respectively, of the top ones of drill string segments **17** in each drill string **10**, as illustrated in FIG. **2**. Furthermore, the segment interior **23** of each segment bit **28** is also provided with interior splines **24** and interior spline slots **25**, for interlocking and nesting with the exterior spline slots **20** and exterior splines **19**, respectively, of the last one of drill string segments **17** in each drill string **10**, to effect rotation of segment bit **28**.

Referring now to FIGS. **7** and **8** of the drawings, in another preferred embodiment of the invention the drill string segments **17** are provided with a segment cable **33**, one end of which is fitted with a cable stay **34**, and the other end threaded through the tip aperture **22** of the last one of drill string segments **17** in each drill string **10**, and then through the tip aperture **22** of each of the nested drill string segments **17**, for attachment to drive housing **11**. In this manner one or more drain holes **35** can be drilled according to the procedure hereinafter outlined, and each drill string **10** can be retrieved from the drain hole **35** by application of segment cable **33**, as illustrated in FIG. **8**. In a most preferred embodiment of the invention each one of segment bits **28** is about 15 to about 20 percent larger than the drill string segments **17**, to better facilitate retrieval of the drill string **10**, and is left in the drain hole after the drilling operation has been completed, as hereinafter described. Furthermore, in this embodiment of the invention, bottom end **31** of guide tubes **29** is flared or enlarged, as illustrated in FIGS. **2** and **8**, to accommodate the enlarged segment bit **28**.

In operation, and referring again to the drawings, a downhole drilling apparatus **1** of appropriate size to fit inside the casing **7** of a well is attached to a wire line cable **5** and is lowered into the well bore casing **7** to a desired predetermined point adjacent a hydrocarbon-producing interval **9**, as illustrated in FIG. **1**. The packer **3** is then activated to secure downhole drilling apparatus **1** in casing **7**, and drive motor **12** is energized. This action causes drill strings **10** to rotate in guide tubes **29** through the action of drive gear **15** and drill string gears **16** and the interlocking and nesting relationship between successive drill string segments **17**. As segment bits **28** rotate, the bits bore initially through each plug **32** in the bottom ends **31** of guide tubes **29**, and then through casing **7** and cement **8**, and finally drill into the producing interval **9**, as illustrated in FIG. **2**. The advancement of segment bits **28** and drill strings **10** through producing interval **9** to create drain holes **35** is effected by the telescoping action of lower guide sleeve **29** and upper guide sleeve **40**, and by the weight of drive housing **11**, which bears on drill strings **10** and applies sufficient pressure on the nested drill string segments **17** to cause segment bits **28** to bore through the surrounding strata. It will be appreciated that under circumstances where the weight of the drive housing **11** is insufficient to load the drill strings **10** to the extent that segment bits **28** will readily bore through the casing **7**, concrete **8** and producing interval **9**, additional weight can be added to drive housing **11**, as desired, by raising the down hole drilling apparatus **1**. This weight can be added in the form of round plates which are shaped to fit inside housing **2** and rest on the top drive housing **11**. When it is desired to remove the drill strings **10** from the drain holes **35**, tension is applied to drive housing cable **36** to raise drive housing **11** and remove the drill strings **10** from drain holes **35** by the action of segment cables **33**, leaving segment bits **28** in drain holes **35**, respectively, as illustrated in FIG. **2**.

Referring now to FIGS. **9** and **10**, in a most preferred embodiment of the invention the taper of exterior splines **19** in transverse relationship to the longitudinal axis of the splines in uneven, with the right-hand clockwise taper being smaller in surface area than the left when each drill string segment **7** in question is viewed from the bottom, as illustrated in FIG. **10**. It has surprisingly been found that when the drill string segments **17** are so designed, a counter-clockwise rotation of the drill strings **10** is much smoother than is the case under

circumstances where the exterior splines **19** of drill string segments **17** are uniformly shaped and uniformly transversely tapered, as illustrated in FIGS. **3–5**. Conversely, if the drill strings **10** are to be driven in the clockwise direction by a counterclockwise rotation of drive gear **15**, then the taper of exterior splines **19** should be reversed from the configuration illustrated in FIG. **10**. As illustrated in FIG. **9**, the transverse taper of interior splines **24** is also offset in the same manner as that of the exterior splines **19**, to match the taper of exterior spline slots **20**, in order to insure proper registration and stacking of the drill string segments **17**.

It will be further appreciated by those skilled in the art that substantially any number of exterior splines **19**, exterior spline slots **20**, interior splines **24** and interior spline slots **25** can be provided in the design of drill string segments **17**. However, in a preferred embodiment of the invention nine exterior splines **19**, exterior spline slots **20**, and matching interior splines **24** and interior spline slots **25** are provided for each one of drill string segments **17**, as illustrated in FIGS. **3–5**. In a most preferred embodiment, the nine exterior splines **19** and interior splines **24** are unequally tapered for optimum smoothness of rotation of drill string segments **17**, as illustrated in FIGS. **9** and **10**.

It will be appreciated by those skilled in the art that the downhole drilling apparatus of this invention can be sized such that the housing **2** will slidably fit substantially any well casing. For example, under circumstances where the casing inside diameter is 4.09 inches, the diameter of housing **2** can be about 3.9 inches. Under these circumstances the radius of curvature of guide tubes **29** should be about 3.8 inches to facilitate a smooth curvature in which to stack drill string segments **17**. Under circumstances where the casing inside diameter is 5.012 inches, a downhole drilling apparatus housing outside diameter of about 4.9 inches can be used, with guide tubes **29** having a radius of curvature equal to about 4.8 inches. Furthermore, the guide tubes **29** and drill string segments **17**, as well as the segment bits **28**, can be manufactured to selected specifications, depending upon the size of the housing **2** and the desired size of the drain holes **35**.

While additional guide tubes **29** can be installed in housing **2**, in a most preferred embodiment of the invention two such guide tubes are preferred for simplicity of operation and to reduce the amount of weight necessary for application to drill strings **10** in order to achieve efficient cutting by segment bits **28**. It will, however, be appreciated by those skilled in the art that a single drill string **10** and guide tube **29** can be used, as desired.

It will be further appreciated by those skilled in the art that the downhole drilling apparatus of this invention can be used in substantially any application where a transverse, off-set hole must be drilled from a primary bore. Accordingly, the apparatus is not limited to use in drilling drain holes in oil and gas wells, but may also be used in such applications as conduit installation and other applications where transverse off-shoot tunnels are necessary from primary borings.

Having described my invention with the particularity set forth above, what is claimed is:

1. A downhole drilling apparatus for boring holes in a production interval of an oil or gas well comprising:

(a) a tubular housing having a diameter of sufficient size to fit in said well;

(b) at least one guide tube having one end attached to the wall of said housing and the opposite end curving upward to define a 90 degree arc, and terminating at a point opposite and above said one end;

(c) a plurality of drilling segments positioned in said at least one guide tube, each of said segments having a round head and multiple, exterior splines and exterior spline slots tapering in spaced relationship from said head to a tip, and further comprising multiple interior splines and interior spline slots for registering with said exterior splines and said exterior spline slots, respectively, of adjacent ones of said drilling segments, and interlocking said drilling segments in stacked relationship to form a drill string in said at least one guide tube;

(d) drill bit means cooperating with the bottom one of said drilling segments in said drill string; and

(e) drive means slidably mounted in said tubular housing and cooperating with the top one of said drilling segments and resting on said drill string to effect rotation of said drill string and boring of said drill bit means and said drill string into said production interval of said well responsive to slidable descent of said drive means in said tubular housing.

2. The downhole drilling apparatus of claim **1** wherein said at least one guide tube is a pair of guide tubes in oppositely disposed relationship in said tubular housing.

3. The downhole drilling apparatus of claim **1** wherein said drive means further comprises a drive housing slidably fitted inside said tubular housing and containing a drive motor and a drive gear rotatably driven by said drive motor, and further comprising at least one drill string gear mounted on said top one of said drilling segments and meshing with said drive gear to effect rotation of said drill string and said drill bit means when said drive motor is energized.

4. The downhole drilling apparatus of claim **1** wherein:

(a) said at least one guide tube is a pair of guide tubes in oppositely disposed relationship in said tubular housing; and

(b) said drive means further comprises a drive housing slidably fitted inside said tubular housing and containing a drive motor and a drive gear rotatably driven by said drive motor, and further comprising a drill string gear mounted on said top one of said drilling segments in each of said guide tubes and meshing with said drive gear to effect rotation of said drill string and said drill bit means when said drive motor is energized.

5. The downhole drilling apparatus of claim **1** further comprising a packer attached to the lower end of said tubular housing for engaging the walls of said well bore and stabilizing said apparatus in said well bore.

6. The downhole drilling apparatus of claim **1** further comprising a packer attached to the lower end of said tubular housing for engaging the walls of said well bore and stabilizing said apparatus in said well bore; and wherein:

(a) said at least one guide tube is a pair of guide tubes in oppositely disposed relationship in said tubular housing; and

(b) said drive means further comprises a drive housing slidably fitted inside said tubular housing and containing a drive motor and a drive gear rotatably driven by said drive motor, and further comprising a drill string gear mounted on said top one of said drilling segments in each of said guide tubes and meshing with said drive gear to effect rotation of

said drill string and said drill bit means when said drive motor is energized.

7. The downhole drilling apparatus of claim 1 wherein said multiple exterior splines and exterior spline slots is nine exterior splines and exterior spline slots in spaced, alternating relationship on the exterior surface of said drilling segments, and said multiple interior splines and interior spline slots is nine interior splines and interior spline slots in spaced, alternating relationship in the hollow interior of said drilling segments.

8. The downhole drilling apparatus of claim 1 further comprising a packer attached to the lower end of said tubular housing for engaging the walls of said well bore and stabilizing said apparatus in said well bore; and wherein:

(a) said at least one guide tube is a pair of guide tubes in oppositely disposed relationship in said tubular housing;

(b) said drive means further comprises a drive housing slidably fitted inside said tubular housing and containing a drive motor and a drive gear rotatably driven by said drive motor, and further comprising a drill string gear mounted on said top one of said drilling segments in each of said guide tubes and meshing with said drive gear to effect rotation of said drill string and said drill bit means when said drive motor is energized; and

(c) said multiple exterior splines and exterior spline slots is nine exterior splines and exterior spline slots in spaced, alternating relationship on the exterior surface of said drilling segments, and said multiple interior splines and interior spline slots is nine interior splines and interior spline slots in spaced, alternating relationship in the hollow interior of said drilling segments.

9. The downhole drilling apparatus of claim 8 wherein said exterior splines and said interior splines are provided with an unequal taper transverse to the axis of said splines, and said unequal taper is uniform on corresponding faces of said exterior splines and said interior splines.

10. The downhole drilling apparatus of claim 8 further comprising a pair of telescoping sleeves each having one end slidably carried by said opposite end of one of said guide tubes and the opposite end of said telescoping sleeves attached to said drive housing for supporting the upper end of said drill string and telescoping responsive to descent of said drive housing in said tubular housing.

11. The downhole drilling apparatus of claim 1 or 9 or 10 further comprising a segment cable extending from said drive means through said drilling segments and attached to said bottom one of said drilling segments whereby said drill string is retrieved from said holes after said boring is completed responsive to upward movement of said drive means in said tubular housing.

12. The dowhole drilling apparatus of claim 1 further comprising telescoping sleeve means cooperating with said opposite end of said at least one guide tube and attached to said drive means for supporting the upper end of said drill string and telescoping responsive to descent of said drive means in said tubular housing.

13. A downhole drilling apparatus for drilling drain holes in a production interval at essentially right angles to the well bore of an oil or gas well comprising:

(a) a generally cylindrically-shaped housing for insertion in said well bore;

(b) a pair of curved, hollow guide tubes having one end attached to opposite interior sides of said tubular housing and extending upwardly in crossed relationship and spanning the width of said tubular housing, with the opposite end of each of said guide tubes terminating in upward-standing position;

(c) a plurality of drilling segments arranged in stacked and nested relationship in each of said guide tubes to shape a pair of flexible drill strings, said drilling segments each characterized by a round head and multiple exterior splines and alternating exterior spline slots tapering in spaced relationship from the periphery of said head to a tip, and further including a hollow interior shaped to define multiple interior splines corresponding to said exterior spline slots, and interior spline slots corresponding to said exterior splines, to facilitate registration of said exterior splines and exterior spline slots of one of said drilling segments with said interior spline slots and said interior splines of an adjacent one of said drilling segments, respectively, and nesting of said drilling segments to form said drill strings;

(d) A drill bit having a drilling surface and multiple interior splines and interior spline slots for registering with the exterior spline slots and exterior splines, respectively, of the bottom ones of said drilling segments in said drill strings;

(e) a drive housing slidably positioned in the upper end of said tubular housing;

(f) a segment cable extending from said drive housing through said hollow interior of said drilling segments in each of said drill strings and attached to said bottom ones of said drilling segments whereby said drill strings are retrieved from said drain holes responsive to upward movement of said drive housing;

(g) a drive motor mounted in said drive housing and provided with wiring for energizing said drive motor from the surface of said well, and a drive gear rotatably driven by said drive motor; and

(h) a pair of drill string gears carried by the top ones of said drilling segments in said drill strings and cooperating with said drive gear to effect rotation of said drill strings and said drill bit when said drive motor is energized.

14. The downhole drilling apparatus of claim 13 wherein said exterior splines and said interior splines on said drilling segments, and said interior splines on said drill bit are provided with an unequal taper transverse to the axis of said splines, and said unequal taper is uniform on corresponding faces of said exterior splines and said interior splines.

15. The downhole drilling apparatus of claim 13 further comprising telescoping sleeves, each having one end slidably attached to said opposite end of one of said guide tubes and the opposite ends of said sleeves attached to said drive housing for supporting the upper end of said drill strings and telescoping responsive to descent of said drive housing in said tubular housing.

16. The downhole drilling apparatus of claim 13 further comprising telescoping sleeves each having one end slidably attached to said opposite end of one of said guide tubes and the opposite ends of said sleeves attached to said drive housing for supporting the upper

end of said drill strings and telescoping responsive to descent of said drive housing in said tubular housing, and wherein said exterior splines and said interior splines on said drilling segments and said interior splines in said drill bit are provided with an unequal taper transverse to the axis of said splines, and said unequal taper is uniform on corresponding faces of said exterior splines and said interior splines.

17. The downhole drilling apparatus of claim **13** wherein a first angle of taper of said exterior splines from said head to said tip is about 30 degrees, and a second angle of taper of said interior splines from said head to said tip is about 10 degrees.

18. The downhole drilling apparatus of claim **13** further comprising telescoping sleeves, each having one end slidably attached to said opposite end of one of said guide tubes and the opposite ends of said sleeves attached to said drive housing for supporting the upper end of said drill string and telescoping responsive to the descent of said drive housing in said tubular housing, and wherein:

(a) said exterior splines and said interior splines on said drilling segments, and said interior splines on said drill bit are provided with an unequal taper transverse to the axis of said splines, and said unequal taper is uniform on corresponding faces of said exterior splines and said interior splines; and

(b) a first angle of taper of said exterior splines from said head to said tip is about 30 degrees, and a second angle of taper of said interior splines from said head to said tip is about 10 degrees.

19. The downhole drilling apparatus of claims **13** or **18** further comprising an enlargement in said one end of said guide tubes and wherein said drill bit is larger in diameter than said drilling segments and normally registers with said enlargement in said one end of said guide tubes prior to drilling said drain holes.

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